aurantiaco, triangulare vel semitriangulare, parte apicali insigniter maculis varisque fusco-purpureis ornato; stigmate subrotundo.

× CYPRIPEDIUM **Andrewsii**, hyb. nov. (*C. candidum* × *C. parviflorum*). Plants 16–40 cm. tall, 1–2 flowered; leaves oval-lanceolate, acute; sepals and petals greenish, much suffused with madder-purple; sepals ovate-lanceolate, 25–37 mm. long; petals lanceolate, 30–40 mm. long; lip 20–25 mm. long, white to cream-colored, conspicuously striped on the interior with violet; staminodium orange-yellow, triangular to semi-triangular (Figures 2, 3 & 4), 4 mm. wide and 9 mm. long, marked in the apical region with spots and blotches of purple-brown; stigma roundish. Type sheet in the herbarium of the Milwaukee Public Museum, Cat. No. 70803, sheet I. June 2, 1931, Swan Lake, Columbia County, Wisconsin. Collected by A. M. Fuller and Harold Staffeld. A co-type specimen and an autochrome photograph have been deposited in the Gray Herbarium.

Mr. Stephen Kliman of the Milwaukee Public Museum made the drawings and supplied the Latin diagnosis. The writer is also indebted to Dr. N. C. Fassett, Mr. S. C. Wadmond, Dr. Ira Edwards and Mr. Gerald Teyen for looking over the manuscript.

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Milwaukee, Wisconsin.

BOTANICAL EVIDENCE OF A POST-PLEISTOCENE MARINE CONNECTION BETWEEN HUDSON BAY AND THE ST. LAWRENCE BASIN

DAVID POTTER

(*Continued from p. 89*)

MARINE SUBMERGENCE IN THE HUDSON BAY REGION

Bell, Low, Wilson, Tyrell and others have conclusively proven that a post-glacial submergence occurred in the Hudson Bay region, which covered a vast territory to the east, west, and south. This area is covered by a mantle of marine clays containing many fossils which are identical with those reported from the St. Lawrence Basin.

TABLE 3 gives a list of some of the localities where these marine fossils have been found. The stations of TABLE 3 have been plotted on the accompanying large map and are indicated by solid black circles. Based upon the known fossiliferous areas, the extent of the marine invasion from James Bay has been shown to reach nearly to that of the St. Lawrence Basin. The area indicated is probably not

TABLE 3

Location	Height in feet above sea level		Authority
Round Bay, 125 miles from the mouth of Moose River	300	marine shells	Bell (5)
Missinabi Lake and along Missinabi and Moose Rivers	300	marine shells	Bell (8) McLean (46)
Nelson river, 54 miles upstream	200	marine shells	Bell (3, 4)
Nelson river, above the third Limestone rapid	200	marine shells	Bell (4)
Churchill river, 60 miles from its mouth	350	marine shells	McLean (3)
Kenogami river	450–500	marine shells	Bell (6, 7)
Little Churchill river	60	marine shells	Alcock (1)
Winisk river	350	marine shells	McInnes (45)
Mammamemmatawa	380	marine silts	Williams (65)

inclusive enough to show the outer margin of submergence, for Low (41), in his work along the east coast of James Bay, discovered sediments and terraces probably of marine origin up to at least 675 feet. In discussing this situation he states: "The evidence of stratified deposits of marine sands and clays along the valleys, near the mouths of the rivers on the east side of Hudson Bay, show that a subsidence of the land over 500 feet (and probably 700) took place after the period of glaciation." Bell (8) further supports this contention, for he says: "On the islands and shores all along the Eastmain coast, the 'raised' beaches are very conspicuous at all heights up to about 300 feet immediately near the sea, but, no doubt, higher ones would be found further inland."

The problem of finding fossil-bearing clays and sands in this region and farther southward is a difficult one due to the ground-cover, which is for the most part boggy or heavily wooded, with considerable accumulation of peat. Even though much of this area has been explored by Canadian geologists, their work has been for the most part concerned with the economic aspects of geology and Pleistocene phenomena have not been thoroughly investigated. Thus, with the difficulties of exploration coupled with lack of interest, it is not surprising that relatively few localities of fossiliferous clays or sands have been reported. For the majority of places given in TABLE 3, we are indebted to the early Canadian geologist, Bell, who, in speaking of the Churchill River says (3): "As the bank continued with the same characteristics for a long distance upstream, I have no doubt that shells may be found at a greater distance inland than that at which they were observed by myself."

It would seem, therefore, justifiable to extend the southern boundary of the marine invasion from the head of Hudson Bay, at least to within a comparatively short distance from the divide. This has been done on the map representing this submergence and the area involved indicated by horizontal lines.

Discussion of the Area Across the Height of Land between James Bay and the Ottawa Valley

Reference to the accompanying map will show that the region under discussion includes the Lake Temiskaming and Lake Abitibi districts, the two areas separated by the divide, the lowest point of which is 914 feet[1] above sea level and occurs just southwest of Lake Abitibi. Examination of the superficial covering of this intermediate area has shown that the entire region up to altitudes of 1000 feet (35) is overlain by clays which were water-laid, for Coleman (21) has shown that this region was once covered by a vast body of water, which he designated as Lake Ojibway.

On the large map certain elevations are shown which are based upon Fairchild's isobases and which, according to him, are theoretical elevations of marine waters (26, 27). These localities are represented by solid black triangles. Table 4 lists the above regions together with their altitudes and approximate locations.

Table 4

Location	Approx. Latitude	Approx. Longitude	Height in feet above sea level
Lake St. John	48° 30′	72° 15′	1000
Saint Anne River	47° 0′	72° 0′	970
Jacques Cartier River	47° 0′	71° 30′	950
Saint Lawrence Valley, Quebec	46° 50′	71° 10′	925
Montmorency, River Laval	47° 0′	71° 0′	940
Chateau Richer	47° 10′	70° 50′	925
Montreal	45° 30′	73° 50′	840
North River, Sainte Marguerite	46° 0′	74° 0′	880
West River, La Chute	45° 45′	74° 30′	825
Ottawa	45° 30′	75° 50′	700
Mattawa	46° 30′	78° 50′	700
North Bay	46° 20′	79° 30′	675

The 700-foot isobase extends from the Lake Temiskaming region southeastward along the Ottawa River and passes through Ottawa city. Since marine fossils have been found in the Grenville District, Ontario, up to 735 feet above sea-level (22), it must follow, if Fair-

[1] Elevation taken from "Altitudes in Canada," James White, Commission of Conservation, Canada.

child's isobase for 700 is correct, that the marine waters extended up to and included Lake Temiskaming, since at the present time the altitude of the lake is about 590 feet above sea level. Again, the topography of the Lake Temiskaming region is such as to make this highly probable. The area lies wholly within the Laurentian Plateau and may be divided into three sections: (1), rocky uplands; (2), clay belt; and (3), linear valleys. The linear valleys have been brought about by erosion along planes of faulting, and are probably pre-glacial, for as Wilson says: " . . . they cannot possibly be of post-Glacial origin because stream dissection since the Glacial epoch has been almost insignificant and the valleys are themselves occupied by glacial drift deposited by the ice-sheets. It is also very improbable that they are the result of glacial denudation, for they have no relationship to the character of the rocks they traverse, and they trend, in some cases, at right angles to the direction of ice movement. Since the valleys are neither Glacial nor post-Glacial in their origin, it follows, *a priori*, that they are pre-glacial valleys." The depression occupied by Lake Temiskaming and the Ottawa river between the lake and the village of Mattawa has a length of about 100 miles and a depth, in places, at present only 100 feet above sea level.

The 800-foot isobase extends from the region just north of Lake Temiskaming southeastward, crossing the St. Lawrence just west of Montreal, thence to Sherbrook where the line turns northeast, passing just north of Tring Junction in the Chaudière valley. Between this line and the 900-foot isobase occur many raised beaches, of which the following may be mentioned: that lying slightly to the northeast of Allumette Island at 800 feet; that at Lake Maskinonge at 865 feet; and at St. Jerome at 900 feet. In addition, still higher beaches have been described at Kingsmere Mountain (north of Ottawa) at 965 feet, and at La Chute at 1000 feet above sea level.

The extension of the northern margin of the previously discussed Champlain Submergence toward the north would thus seem justified, if Fairchild's isobases are substantially correct and these raised beaches are of marine origin. In further support of this extension of sea-margin, Taylor says in discussing the limit of post-glacial submergence in the highlands east of Georgian Bay: " . . . the facts show clearly that the same water that filled the ancient channels in the southern highlands extended far to the north and west. It evidently covered all the lowlands of this region and, as indicated by the altitude of the shore line, made a strait over Lake Nipissing at least twenty-five miles wide and five hundred feet deep, and probably another farther north over the height of land to Hudson Bay." In a later paper Taylor says: "There can be no doubt of the recent presence of wide waters at high levels over Lake Nipissing and the headwaters of the Mattawa river. At the five places seen in the Ottawa valley, however, no clear and certain evidence of high level submergence was found, except, perhaps, the thin silts and clays overlying the drift south of Mattawa, up to about eight hundred feet. This limit for such a deposit would seem to imply a contemporary water surface at a still higher level, and it is more than probable that for a comparatively brief period such an eastward extension actually existed." One more note from Taylor's researches may not be amiss. In speaking of the history of the Great Lakes he says (60): "At their highest level, the Great Lakes had open connection with waters to the east through a broad strait at Nipissing, and it now seems possible that they had another to the northeast. It is not yet proved that these connections were with the ocean, but I believe that the evidence tends more and more strongly toward that conclusion." Coleman (21), in his discussion of Lake Ojibway, admits the possibility of this lake having been united to the sea; for he says " . . . whether any portion of the bed of Lake Ojibway was covered by the sea is uncertain."

Duration of the Submergences

Antevs (2) has estimated about 30,000 years as necessary for the retreat of the ice sheet from the terminal moraines in New York State to Cochrane, Ontario. The retreat from Stony Lake, Ontario (which on the map included in this paper would be located approximately at latitude 44° 30′, longitude 72°) to Mattawa, Ontario, required 13,000 years. According to his map (p. 164), the marine stage in the St. Lawrence Basin was inaugurated at the time the ice sheet stood at Stony Lake. He concludes his studies with the following statement: " . . . the last ice sheets had their greatest extent and began to wane about 40,000 years ago. This figure may be less than 10,000 years too large or too small . . . " If this is approximately correct it may be safely concluded that the ice disappeared from the Hudson Bay region about 35,000 years ago.

Since the retreat of ice from the terminal moraines of New York State to Stony Lake, Ontario, consumed 17,000 years, it follows that the Champlain submergence was inaugurated about 16,000 years B. C. This marine invasion was probably of considerable duration. Taylor (62) has shown in his paper entitled "New Facts on the Niagara Gorge" that the outlet at North Bay, Ontario, was closed by uplift about 3000 years ago. Mather (44) in his studies on the Champlain Sea in the Lake Ontario basin states: "That the uplift of the St. Lawrence region, in greater part at least, lagged considerably after the removal of ice." In further support of the length of life of the Champlain Submergence, Coleman says (20); "This inland sea must have existed for a long period because clay-forming sediments accumulated to a thickness of one hundred and fifty feet or more in some parts of the basin and filled up all the hollows and formed a fairly level sea-floor." Keele (38) substantiates this view, stating that the clay deposits of the St. Lawrence basin vary in thickness up to a maximum of about 200 feet.

In the Hudson Bay region marine fossils have been found up to approximately 500 feet above sea level. The evidence of raised beaches in this area further suggests that the marine waters stood about 700 feet higher than is the case at present. Uplift has thus taken place and, according to Bell (8), at the rate of five to ten feet per century. If uplift has been more or less uniform, the time consumed since this differential elevation began would be between 5000 and 14,000 years. That this land-elevation has been more or less uniform seems to be the case, for Ells (25) found that the thickness of moss and peat increased toward the south as follows: "Eight miles west of Moose Factory the moss and peat was two to three feet thick. Ten miles farther south, two to four feet, forty miles south, four and a half to five feet, sixty miles to eighty miles south, five and a half to six feet and ninety miles south, six to eight feet." It would be fairly safe to conclude, therefore, that at one time during the existence of these two marine invasions they were contemporaneous.

As pointed out earlier in this paper, the Lake Temiskaming and Lake Abitibi regions were also inundated, although perhaps for a shorter period of time than for the two submergences just discussed. Cooke (22) concludes from his studies of the Lake Temiskaming region that the waters covering this area must have existed at least 2500 years. Furthermore, the clays of the Abitibi district (Lake Ojibway) are, according to Knight, Barrows, Hopkins, and Parsons (39), about seventy feet in thickness. If there is a correlation between the depth of deposition of clay and the length of life of a body of water, it follows that the waters over the height of land existed for a considerable length of time, since as already pointed out, the length of life of the Champlain Submergence was comparatively long, with a clay deposition of about two hundred feet.

From the foregoing discussion it would seem probable that a water-connection existed for at least a short period of time between the St. Lawrence Basin and Hudson Bay.

So far no marine fossils have been found in this intermediate region, although in places diligent search has been made (10). The absence of fossils, however, may be due to the great influx of fresh waters, in this area from the lakes to the west, through the strait at Nipissing and also from the retreating ice front. This influx would have made the waters of the invasion brackish and might have so modified the salt constituents as to have forbidden the presence of marine forms, or at least have reduced their numbers. This fact, supported by the comparatively short life of the probable marine connection, the erosion and the leaching out of the deposits and the possible presence of certain chemicals, which would militate against the preservation of shells, may account for the absence of fossiliferous clays and sands. Furthermore, as already noted, no living marine mollusks have been found in James Bay even though the connection with the sea is direct and the waters of the Bay brackish (9).

From the foregoing studies, it seems evident that it is justifiable to extend the northern margin of the St. Lawrence marine invasion to at least the region of Lake Temiskaming, and the southern margin of the Hudson Bay marine submergence to a point a few miles from the present height of land. Even if the intermediate region was not covered by marine waters, the two sea-margins were close enough to allow ordinary agents of local seed-dispersal to become operative and to bridge the gap, so that plants growing along the shores of the southern waters might establish themselves in the maritime habitats of the northern invasion.

Summary

If this theory of a marine connection between the St. Lawrence Basin and James Bay is correct, a pathway was open after the recession of the Wisconsin Ice Sheet for the migration of plants of maritime requirements from the south to James Bay along the shores of these inland seas. Two sources of evidence would aid tremendously in establishing this theory: namely, the finding of marine fossils in the intermediate zone and the persistence of some maritime plants in this interior region. As stated above, no fossiliferous marine clays have been found north of Mattawa until the marine deposits are met about one hundred and twenty-five miles south of James Bay.

In only one case have any halophytes been reported from the region under discussion and in this case the identification is open to doubt (35). This lack of halophytes in the interior is more or less to be expected, for unquestionably considerable erosion and leaching of the soil has occurred since the end of the marine stage, which would have changed the edaphic conditions enough to have forced these plants to abandon the region.

Olsson-Seffer (47) has shown that each species of plant has a maximum salt requirement to which it is very accurately adapted and that this maximum cannot be overstepped without fatal results to the plant. Thus, in the case of *Glaux maritima*, 2.7 *per cent* is the maximum; with *Juncus Gerardi*, 2.2 *per cent;* with *Triglochin maritima*, 2.6 *per cent*, and with *Elymus arenarius*, 2.6 per cent. It naturally follows that there must be a minimum salt requirement for halophytes, and since the maximum in most cases is relatively slight, the leaching out of this amount after land-elevation took place would not require a very long period of time. As was noted earlier in this paper, the halophytes under discussion do not now occur in much of the region which was known to have been submerged and whose soil about the margin of the sea unquestionably supported these plants for a time after land-elevation. Svenson (56) has pointed out that the occurrence of several of these maritime plants about the Finger Lakes region of New York State is due to the presence of salt springs, rather than to salt deposits during the Champlain Submergence.

Nevertheless, the occurrence of raised beaches all along the St. Lawrence Basin at altitudes up to 1000 feet, the raised beaches along the east coast of James Bay, the isobases of Fairchild, the depth of clay-deposits and the occurrence of maritime plants in the Hudson Bay region all lend strong support to the theory that there existed after the Wisconsin glaciation a marine connection between Hudson Bay and the St. Lawrence Basin, and Guppy (34) is probably correct in saying: "The witness of the living plant is often quite as insistent as the testimony of the rocks."

Conclusion

From the above studies the following statements seem justified:

1. A marine invasion occurred in the St. Lawrence Basin after the recession of the Wisconsin Ice Sheet, which probably extended north to include the Lake Temiskaming region.

2. A similar invasion of the sea occurred in the Hudson Bay region contemporaneous with that of the St. Lawrence Basin, which extended southward to within a few miles of the height of land.

3. Evidence seems to indicate that a possible marine connection existed between these two known submergences involving the Lake Abitibi area.

4. Driftless areas have never been found in the Hudson Bay region so that it is improbable that these plants existed within the district during the Wisconsin glaciation.

5. Wind, water and animals do not seem to be the chief factors which brought about the introduction of these halophytes into the Hudson Bay area.

6. The above marine connection (if it existed) would have offered suitable conditions for the migration of halophytic plants along its shores.

7. Undoubtedly the northern margin of the Champlain Sea and the southern margin of the Hudson Bay inundation were relatively close and, even though a marine connection may have been lacking, the factors effecting local plant-distribution may have been sufficient to have bridged the slight gap and thus account for the occurrence of the plants in question in the region of Hudson Bay.

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THE NEW HAMPSHIRE RECORD FOR RYNCHOSPORA TORREYANA.— In the Gray Herbarium there is a specimen received as part of the herbarium of William Boott, correctly identified as *Rynchospora Torreyana* Gray and bearing the data: "Bogs, East Washington, N. H. No. 41 *Legit C. F. Parker*, 1868." When the 7th edition of Gray's Manual was being prepared the label was accepted at its face value and the locality there recorded. *R. Torreyana* occurs as a member of the relic Coastal Plain flora in southeastern Rhode Island, on Cape Cod and on Nantucket; and since the Coastal Plain *Sclerolepis verticillata* (Walt.) BSP. had just been found[1] at its first station north of southern New Jersey, on a pond-shore in Bradford, the town adjoining East Washington on the east, the *Rynchospora* was, very naturally, interpreted as a second species of the New Jersey Pine Barrens which had persisted as a relic in south-central New Hampshire. In September, 1928, familiar with *R. Torreyana* as it grows in Washington County,

[1] F. T. Lewis, RHODORA, vii. 186 (1905).